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The Effectiveness of Manipulatives on Fractions when Teaching 2nd Graders

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Table of Contents

Abstract

Studies show that manipulatives help students grasp concepts that are abstract because it gives them a concrete idea of the concept, (Jao, 2013). Manipulatives are defined as, "a mathematics manipulative material is an object that can be handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered" (Swann & Marshall, 2010, p. 14). However, there is a dearth of research on the effectiveness of manipulatives. The research on manipulatives studies mainly upper elementary and middle school students. Also, the majority of the research is made up of teacher's observations instead of quantitative research that used statistical analysis to explore the effectiveness of manipulatives. Lastly, research shows that many teachers believe that they cannot implement manipulatives effectively while following the guidelines of the Common Core. This study explored the effectiveness of manipulatives while teaching fractions. The research in this study explored the effectiveness by dividing a second grade class into two groups; one group will be taught with manipulatives and the other group will be taught without manipulatives. Data was collected in forms of pretests and posttests and was analyzed to find the effectiveness of manipulatives. The results showed that manipulatives can be effective as well as ineffective.

Introduction

Studies show that manipulatives help students grasp concepts that are abstract because it gives them a concrete idea of the concept, (Jao, 2013). While teachers use manipulatives frequently in the classroom, there is a dearth of research on the actual effectiveness of manipulatives when teaching fractions. Manipulatives are defined as, “a mathematics manipulative material is an object that can be handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered” (Swann & Marshall, 2010, p. 14). This study explored the effectiveness of manipulatives while teaching fractions to second graders. The research in this study explored the effectiveness by dividing a second grade class into two groups; one group will be taught with manipulatives and the other group will be taught without manipulatives. Data was collected in forms of pretests and posttests and was analyzed to find the effectiveness of manipulatives.

Literature Review

The use of manipulatives in elementary classrooms is very common. Teachers have found that manipulatives enable students to grasp abstract concepts because they have a physical object that allows them to connect a concept. Unfortunately, there is little research that support or explain why manipulatives are so effective. This spring, I researched the effectiveness of manipulatives when second graders learn about fractions. While there is a huge emphasis on the students understanding of concepts in math, there is a dearth of research on the use of manipulatives in the classroom. The research that has been done on manipulatives suggests that they are helpful towards the students understanding of concepts. However, there are very few studies on the benefits of manipulatives when teaching fractions. This literature review explores the historical use of manipulatives as well as different uses of manipulatives when teaching fractions.

The Use of Manipulatives

The definition of manipulatives that has been historically used by researchers is "concrete models that incorporate mathematical concepts, appeal to several senses and can be touched and moved around by students" (Hynes, 1986, p. 11). However, with the recent influx of the use of technology and virtual manipulatives, researchers Swann and Marshall (2010) have decided to change the definition. They also changed the definition because they wanted the definition of manipulatives to entail the student's ability to think about a concept while physically interacting with a manipulative. Swann and Marshall (2010) expand the definition by saying, "a mathematics manipulative material is an object that can be handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered" (Swann & Marshall, 2010, p. 14). This allows the definition to encompass the idea that manipulatives provide concrete evidence of an abstract idea that allows students to conceptualize the material. Swann and Marshall found that "manipulatives benefit the learning and teaching of mathematics" (Swann & Marshall, 2010, p. 18). They also found that "all children need access to and availability of a wide range of manipulatives as they meet new mathematical concepts and continue to construct mathematical meanings" (Swann & Marshall, 2010, p. 19). Swann and Marshall also present the problem that "teachers have not been more inclined to question how and if mathematics manipulative materials actually help children learn mathematics" (Swann & Marshall, 2010, p.19). The research done by Swann and Marshall show the positives of using manipulatives during instruction, but they also present the issue of the lack of research done by teachers to see how manipulatives actually help students.

Interestingly, not all teachers agree that manipulatives are so much more than 'hands-on learning.' In the article, "Teacher Learning and Mathematics Manipulatives," the researchers claim that “manipulatives are a much more useful tool for testing out ideas that are slowly emerging within the student rather than understanding a concept after a procedure has been taught” (Puchner, Taylor, O'Donnell, & Fick, 2008, p. 321). However, they found that teachers used manipulatives as “an end in and of itself, rather than a tool leading to better understanding” (Puchner, Taylor, O'Donnell, & Fick, 2008, p. 321). The students would find the answer using a traditional algorithm and then go back and figure out the best way to use the manipulative to confirm their answers. Conversely, it is important for students to use manipulatives as a way for students to find an answer to a challenging problem. In other research done by Uribe-Florez and Wilkins (2010) in “Elementary School Teachers’ Manipulative Use,” it shows that teacher’s lack of knowledge of how to use manipulatives can result in ineffectiveness of manipulatives. Furthermore, the importance of students, “understanding mathematical concepts is essential for the development of mathematical competence, however many students do not have access to instruction that leads to such understanding (NCTM, 2000)” (Puchner, Taylor, O'Donnell, & Fick, 2008, p. 323).

These three research articles show the importance of using manipulatives to teach mathematics. However, Swann and Marshall (2010) have a more effective working definition of manipulatives whereas Puchner et al. (2008) are better at explaining the importance of teaching students how to effectively use manipulatives to solve problems in math. Uribe-Florez and Wilkins (2010) found that it is important for teachers to understand how to use manipulatives because they found that students who used manipulatives did better on assessments than students who did not use manipulatives. This research also shows that teachers either use manipulatives ineffectively or they do not use manipulatives at all.

Manipulatives in Math

Teachers have found that manipulatives have been successfully used in classrooms. However, there is a lack of literature on using manipulatives to teach fractions. In his research article, “5 Tips for Creating Independent Activities Aligned with the Common Core State Standards”, Fraser (2013) says, “when students have the opportunity to practice learned skills using hands-on strategies, concept understanding is enhanced” (Fraser, 2013, p. 9). Many teachers think that it is hard for them to incorporate manipulatives into lessons because of Common Core, but Fraser (2013) states that, “teachers can incorporate hands-on independent learning…while grounding instruction in the current CCSS” (Fraser, 2013, p. 9). He found that “Unifix cubes and Links are two of the most common, generally used for sorting colors and completing patterns” because they “encourage students to "look closely to discern a pattern or structure” (Fraser, 2013, p. 9). He also found that “pattern blocks or tangrams… can be used in more challenging ways, such as by providing students with more blocks than needed for a template” (Fraser, 2013, p. 9). Fraser’s research is important because his research shows the best way to use manipulatives for students while staying aligned to the common core standards.

Jao (2013) found that “representation forms that scaffold the students’ understanding by moving the student from using real-world and concrete representation forms to those more abstract can be fruitful” (Jao, 2013, p. 2). This researcher wanted to show how using manipulatives could scaffold different math concepts for children. The research was single-case and the teacher they focused on used four different types of manipulatives. She used storytelling to help students, counters such as colored stones and toy dinosaurs, drawing representations of manipulatives and symbols such as “=” and “-“ to help the students start to learn about subtraction sentences. The results show that, “concrete representations in the form of manipulatives are a fundamental representation form" (Jao, 2013, p. 10). Jao (2013) explains that her research shows that representations can form scaffolds that help students go from a basic understanding of mathematics to a more abstract understanding of mathematics. Jao suggests that further research can be done to find whether this technique actually "yields increased students understanding" (Jao, 2013, p. 11).

While these articles examine manipulatives, the research questions that the researchers based their experiments on are very different. The first article, written by Fraser (2013), explains the effectiveness and the best way to use manipulatives in a classroom, whereas the second article, written by Jao (2013) explains how manipulatives can build a scaffolding of a concept that helps them understand abstract concepts.

Using Manipulatives to Teach Fractions

In "Fractions from Concrete to Abstract using Playdough Mathematics", Caswell (2007) uses playdough as her manipulative to teach fractions. She worked with students between the ages of 9 to 12. She reports that these have been her experiences with playdough mathematics and that his article is on his tried and true methods. Caswell reports that "many students, however, still need the benefit of concrete materials and sensory motor experiences to enhance their understanding of the concepts associated with common fractions" (Casewell, 200, p. 1). She claims that many researchers state that the use of physical materials allows students to gain a better understanding of abstract ideas. However, she implies that you cannot only rely on manipulatives to teach fractions. Her first experience she shares with the reader introduces the concept by using real world situations as well as using language associated with fractions. Once she explains this, then she introduces playdough as a manipulative. This allows students to explore fractions with a physical representation instead of an abstract concept. Caswell says that

"Students thoroughly enjoy the experience of working with playdough, which stimulates all learners, provides for the needs of a wide range of learning styles, and can be used to support most conceptual learning in mathematics in these middle primary years." (Casewell, 2007, p. 17).

Playdough is only one of the many manipulatives teachers use to teach fractions. Another method that researchers have found to work is manipulating paper. Pearn (2007) performed her study on middle school students and the ""hands on" approach developed by researchers that focuses on the use of paper folding, fraction walls and number lines" (Pearn, 2007, p. 31). Teachers give students paper stripe and ask questions such as, "How do you know you have folded your strip into halves?" (Pearn, 2007, p. 32). Then, teachers give students paper which are cut into squares. They then have them fold the paper in different ways such as diagonally and horizontally. Then, they ask the students if one way of folding the paper makes the half larger than another way of folding a paper. Another way is to have the students draw a certain number of circles and then color in a portion of the circles. The researchers say that "these activities assist students to develop the understanding of fractions rather than rely on rules and procedures without understanding" (Pearn, 2007, p. 36). It is important to know different manipulatives because some students might find one type of manipulative useful while other students might find it useless.

Also, in research done by Witzel and Allsopp (2007) in "Dynamic Concrete Instruction in an Inclusive Classroom," it shows concrete evidence on why manipulative use is important for middle school students with learning disabilities. They say that "teaching practices that enhance instruction using manipulatives will, however, give more students with learning problems an opportunity to experiment with mathematics concepts and to develop greater conceptual understanding" (Witzel & Allsopp, 2007, p. 248). They stress that students cannot only use manipulatives to help them learn. The students need "statements of relevance (teachers helping students to understand the relevance of the topic or concept to their lives through verbal, visual, or other ways)" (Witzel & Allsopp, 2007, p. 248). Witzel and Allsopp (2007) found that giving students with learning disabilities the opportunities to explore concepts using manipulatives will help them develop a greater understanding of abstract concepts and it will give them more confidence.

These three articles have effectively shown which strategies teachers use to incorporate manipulatives to teach fractions. However, the research done only shows which methods are effective qualitatively. There is no quantitative research that supports their findings.

Conclusion

It is important to have a basis of understanding of manipulatives in order to work with them in your classroom. Studies show that manipulatives help students grasp concepts that are abstract because it gives them a concrete idea of the concept, (Jao, 2013). While teachers use manipulatives frequently in the classroom, there is a dearth of research on the actual effectiveness of manipulatives when teaching fractions. This action research project was important, then, because the goal was to find if the manipulatives are being used effectively and if the manipulatives help the students understand abstract concepts. This question was analyzed by looking at student's grades on pretests and posttests and on whether or not they choose to work with manipulatives. The conclusions found will hopefully help future teachers implement manipulatives correctly and effectively.

Methodology

The action research that was conducted in the spring semester explored the effectiveness of manipulatives while teaching fractions in second grade. Action research was the most appropriate method because action research focuses on the ability to “improve the quality of an organization and its performance” (Rigsby, 2005). Since the objective of the question is to improve the method of teaching fractions, action research makes the most sense to use because the whole purpose of action research is to improve the performance of an organization which in this case is the teachers in elementary education. Action research is also used “by practitioners who analyze the data to improve their own practice” (Rigsby, 2005). Since I will be teaching in the near future, this research will be very important to me because I can apply it to my own teaching.

This study was conducted in a suburban elementary school located in Northern Virginia. It was done in a second grade classroom. The demographics of the school are as follows. There are two administrators, 53 teachers and 22 support staff. Students categorized as Limited English Proficiency make up 11% of the population, another 11% is special education and 35% are Economically Disadvantaged students (ECD). The students in the gifted and talented program make up 19% of the population but only 1% of the population has been identified as twice exceptional. The school consists of 53% male and 47% female. This was an appropriate setting to conduct the research because the participants of the research were second graders who were just learning about fractions. Since the second graders needed to be in a school setting for this experiment to work, the suburban elementary school setting was also imperative to the research.

There were 21 students in the second grade, 11 males and 10 females. Of the 21 students, 6 of them were Hispanic, 3 of them were black and 12 of them were white. There were 6 special education students, 4 English as a Second Language students, and 2 Rising Scholar students which was a program that prepared students for SCOPE (Spotsylvania County Program for Enrichment) and there was 1 SCOPE student. Also, 10 of the students were economically disadvantaged students.

In order to effectively do research, the students first took a pretest on fractions (Appendix A). The pretest had 15 questions on fractions. There were five questions on identify the parts of a set that represent fractions, five questions where the students have to write the fraction and five questions where the student will have to compare the unit fractions. These questions covered the Mathematics Standards of Learning (SOL) by covering these points: The student will

a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;

b) write the fractions; and

c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.

Then, the students were split into two groups that were randomly chosen. All of the students were assigned a number. Then the number was placed into a bag and the numbers were drawn randomly and placed into either Group 1 or Group 2. Group 1 used manipulatives when they learned about fractions in the first week and Group 2 did not have any contact with manipulatives during the first week. The students received instruction this way for a week and then they were given a posttest (Appendix B). The questions on the posttest were different problems but covered the same material as did the pretest. There were 15 questions which were based off of the Math Standards of Learning (SOL). The posttest had 15 questions on fractions. There were five questions where students had to identify the parts of a set that represented fractions, five questions where the students had to write the fraction, and five questions where the student had to compare the unit fractions. Then, Group 2 was taught with manipulatives the following week and Group 1 was given the instruction that the other group had but did not use manipulatives. Another posttest (Appendix C) was given to see if there was any improvement or growth between the two groups. This posttest had different problems, but covered the same material as did the pretest. The posttest had 15 questions on fractions. There were five questions where students had to identify the parts of a set that represented fractions, five questions where the students had to write the fractions, and five questions where the student had to compare the unit fractions. Finally, during the third week, the students were given the option to choose to use manipulatives or not. The student's choices were recorded and then at the end of the week a final posttest (Appendix D) was administered. This final posttest had 15 questions on fractions. There were five questions where students had to identify the parts of a set that represented fractions, five questions where students had to write the fractions, and five questions where the student had to compare the unit fractions. This last step in the research helped me understand the student's perceptions of using manipulatives.

There were five sets of data that were collected. A pretest was given to the students to gauge their knowledge and understanding of fractions. Then, a posttest was given after the first week, the second week, and the third week. This posttest was used to see how much they had learned when they used and did not use manipulatives. Then, during the third week, data was collected to see which children decided to use manipulatives and which ones did not use manipulatives. Data was collected by a frequency count (Appendix E) to see how many students chose to work with manipulatives in the third week. Then, once the final posttest was administered, the data from the third posttest (the grades) was sorted into three sections. One section was for students who always used manipulatives in the third week, the next section was for students who sometimes used manipulatives in the third week, and the last section was students who never used manipulatives in the third week.

In order to understand the effectiveness of manipulatives when teaching fractions, the data was analyzed in several ways. First, an average of the pretest's number of questions answered correctly for each of the students was taken as well as the average for each group once they were sorted into groups. Next, an average of the two group's posttests was taken three times (once each week). The number of questions answered correctly from each group were averaged together, then graphed to see any increase or decrease in grades. Since the students studied fractions for three weeks, an increase in knowledge was expected. In order to analyze the data effectively, it was broken down as such: the number of questions answered correctly per students was averaged together to their group and then the two groups averages were compared to one another and graphed each week. Also I took the scores from the previous week average and compared it to the current week average. This was also graphed/charted. Also, using the pretest and the three posttests, the students each had a graph made showing either their increase or decrease in grades on the test. Finally, the observation of which students had used manipulatives and how often they used it or if they do not use it were divided into three sections: students who always used manipulatives, students who never used manipulatives and students who sometimes used manipulatives. Then the grades on the third posttest of the three sections was separated into the three groups and was averaged to see if there were any trends among the final data set. These different ways of collecting and analyzing data hopefully showed trends in the data that they answered the research question. Also, the data analysis was able to show whether the administration and the usage of the manipulatives was effective.

Results

The students were randomly separated into two groups, Group 1 and Group 2. They were all given the same pretests and posttest. Before the first week of learning fractions, a pretest was given. Then, during the first week, Group 1 was taught fractions using manipulatives and the Group 2 was taught without manipulatives. Then, Posttest #1 was given after the first week of teaching. Then, during the second week, the students in the group that were not taught fractions with manipulatives were then taught the same exact lesson that the other group had the week before. And the same went for the group that was taught using manipulatives. They had the same lessons as the other group before them. In order to analyze the results, the averages of the two group tests were taken and compared using the t-test. The results are as follows.

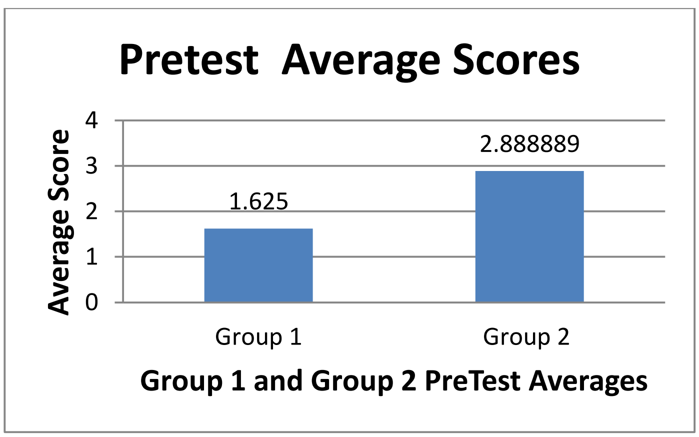

Figure 1. Pretest Average Scores

t-Test: Two-Sample Assuming Unequal Variances

Table 1

	Variable 1	*Variable 2*
Mean	1.625	2.888888889
Variance	3.982142857	2.361111111
Observations	8	9
Hypothesized Mean Difference	0	
df	13	
t Stat	-1.449671706	
P(T<=t) one-tail	0.085421867	
t Critical one-tail	1.770933383	
P(T<=t) two-tail	0.170843733	
t Critical two-tail	2.160368652	

For the first part of the data analysis, the average of the two group's pretests were taken. Looking at the graph, the differences in averages look pretty significant. However, when the t-test was performed on the two groups, (there was an odd amount of students so Group 2 had one more student than Group 1), it shows -2.160< 1.449< 2.160 (-t Critical two-tail<t Stat< +t Critical two-tail) is a true statement which means that there is no rejection of the null hypothesis. Or, there is no difference between the two groups.

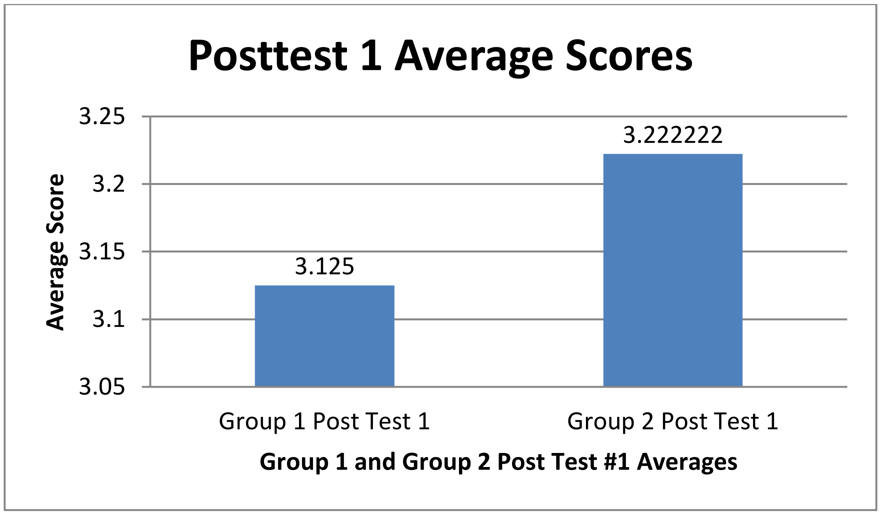

Figure 2. Posttest Average Scores

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	3.125	3.222222
Variance	0.410714	0.444444
Observations	8	9
Hypothesized Mean Difference	0	
df	15	
t Stat	-0.30634	
P(T<=t) one-tail	0.381778	
t Critical one-tail	1.75305	
P(T<=t) two-tail	0.763557	
t Critical two-tail	2.13145	

Table 2

The same can be said for Groups 1 and 2 posttest #1 averages. If you look at the graph displaying the differences in averages, one might think that there is a difference, however, when the t-test was performed, it was found that -2.131< -0.306< 2.131. This shows that there is no rejection of the null hypothesis, or that there is no significant difference.

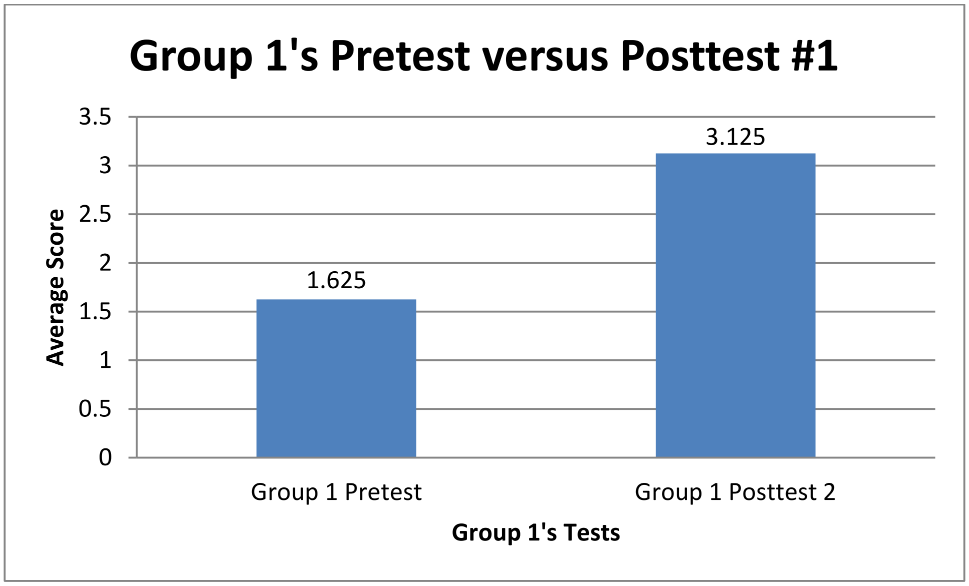

Figure 3. Group 1’s Pretest versus Posttest #1

t-Test: Two-Sample Assuming Equal Variances

	Variable 1	*Variable 2*
Mean	1.625	3.125
Variance	3.982143	0.410714
Observations	8	8
Pooled Variance	2.196429	
Hypothesized Mean Difference	0	
df	14	
t Stat	-2.02424	
P(T<=t) one-tail	0.03123	
t Critical one-tail	1.76131	
P(T<=t) two-tail	0.06246	
t Critical two-tail	2.144787	

Table 3

Looking at Group 1’s Pretest and Posttest #1 comparison, the students made a lot of growth in their understanding of fractions. However, according to the t-test, there is still no significant difference. The statement is -2.144<-2.024<2.144. While the students did make a significant amount of growth there is no correlation to manipulatives being a factor to this growth.

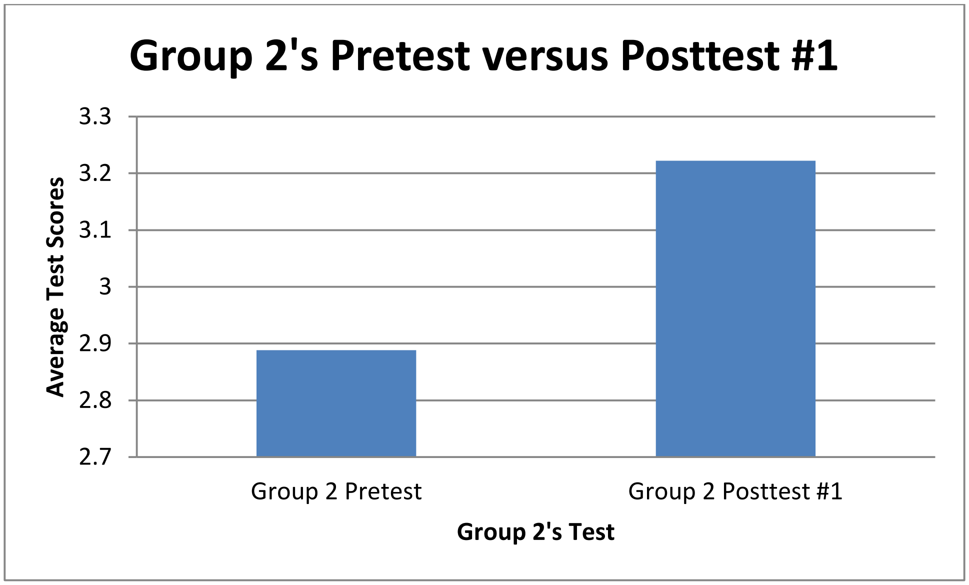

Figure 4. Group 2’s Pretest versus Posttest #1

t-Test: Two-Sample Assuming Equal Variances

	Variable 1	*Variable 2*
Mean	2.888889	3.222222
Variance	2.361111	0.444444
Observations	9	9
Pooled Variance	1.402778	
Hypothesized Mean Difference	0	
df	16	
t Stat	-0.59702	
P(T<=t) one-tail	0.279423	
t Critical one-tail	1.745884	
P(T<=t) two-tail	0.558847	
t Critical two-tail	2.119905	

Table 4

The same is also seen between Group 2’s pretest and posttest #1. While, the students test scores increased, there is still no difference between the two test’s averages when the t-test was run. The statement of the t-test shows -2.119<-0.597<2.119. Since this statement is true, the null hypothesis cannot be rejected.

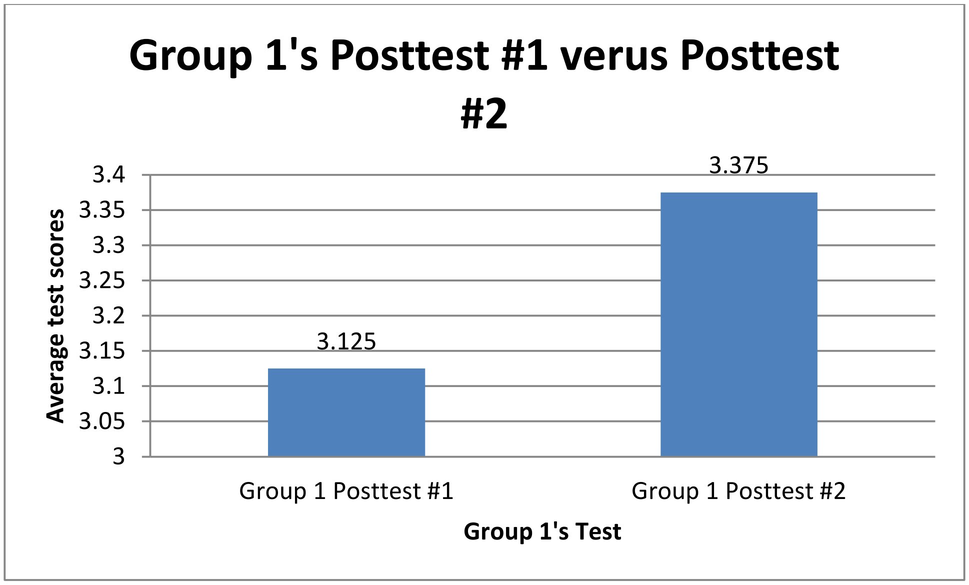

Figure 5. Group 1's Posttest versus Posttest #2

t-Test: Two-Sample Assuming Equal Variances

	Variable 1	*Variable 2*
Mean	3.125	3.375
Variance	0.410714	1.982143
Observations	8	8
Pooled Variance	1.196429	
Hypothesized Mean Difference	0	
df	14	
t Stat	-0.45712	
P(T<=t) one-tail	0.3273	
t Critical one-tail	1.76131	
P(T<=t) two-tail	0.6546	
t Critical two-tail	2.144787	

Table 5

Group 1's Posttest #1 and Posttest #2 also do not have any difference in averages. -2.144<-0.457<2.144 is a true statement so the null hypothesis cannot be rejected.

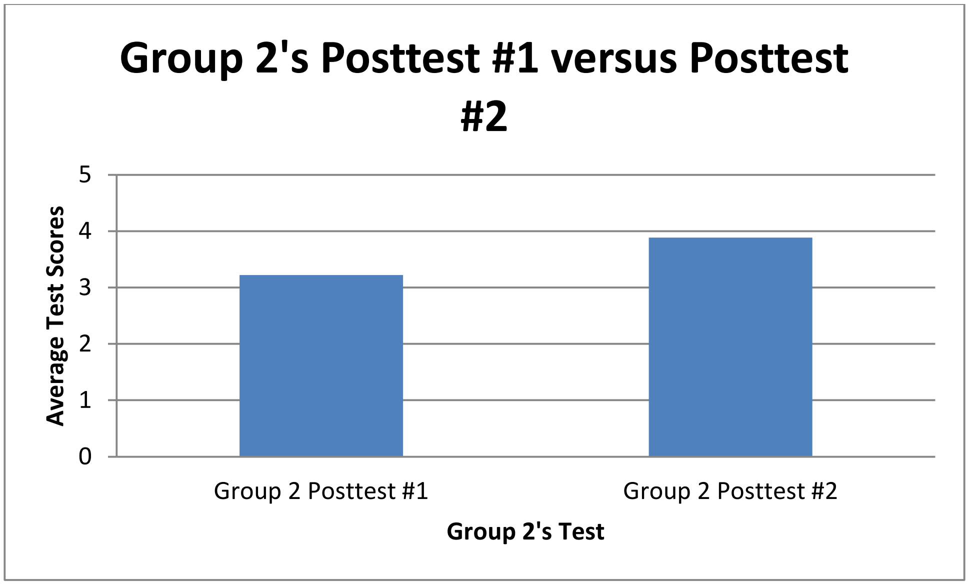

Figure 5. Group 2's Posttest #2 versus Posttest #2

Group 2 posttest 1 versus posttest 2:

t-Test: Two-Sample Assuming Equal Variances

Table 5

	Variable 1	*Variable 2*
Mean	3.222222	3.888889
Variance	0.444444	0.111111
Observations	9	9
Pooled Variance	0.277778	
Hypothesized Mean Difference	0	
df	16	
t Stat	-2.68328	
P(T<=t) one-tail	0.008161	
t Critical one-tail	1.745884	
P(T<=t) two-tail	0.016321	
t Critical two-tail	2.119905	

However, there is a significant difference between Group 2's Posttest #1 and Posttest #2. The statement, -2.119<-2.683<2.119 is NOT true. So the null hypothesis can be rejected.

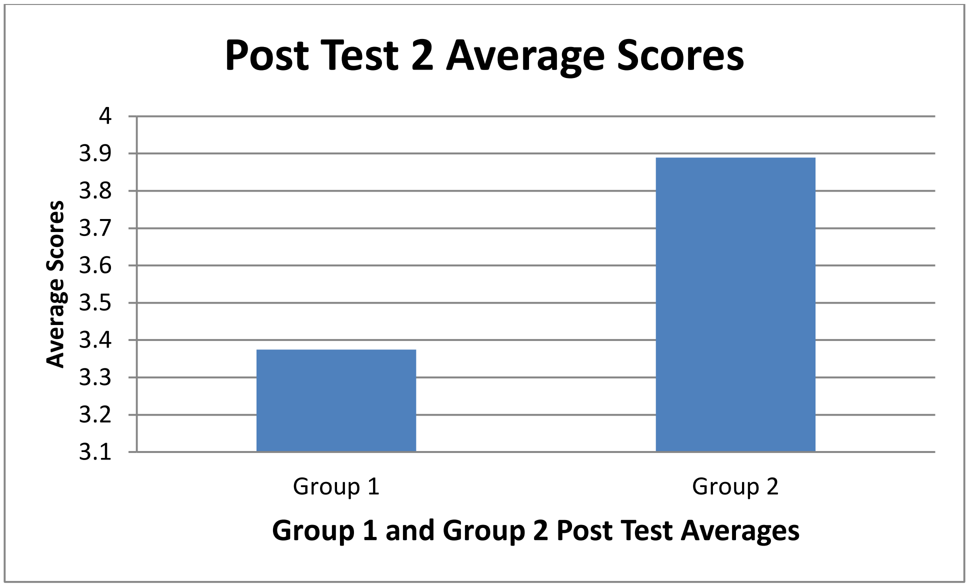

Figure 6. Posttest Average Scores

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	3.375	3.888889
Variance	1.982143	0.111111
Observations	8	9
Hypothesized Mean Difference	0	
df	8	
t Stat	-1.0076	
P(T<=t) one-tail	0.171574	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.343147	
t Critical two-tail	2.306004	

Table 6

And lastly, the two groups averages on Posttest 2 also do not have a difference between the two. The statement -2.306<-1.007<2.306 is true so the null hypothesis cannot be rejected.

In conclusion, the results of the research show that manipulatives might have a direct impact on the effectiveness of teaching fractions. Since the null hypothesis was rejected for Group 2's Posttest #1 and #2, it can be suggested that manipulatives can help students understand abstract concepts.

Discussion

While the students showed incredible growth during the time they learned fractions, the results did not show that manipulatives were entirely helpful for the students. Surprisingly, Group 2's Posttest #1 and #2 did show that there is a difference between the two test score. This leads to the conclusion that the students did not fully understand fractions the first week because they did not have manipulatives and this showed on their test, but during the second week when they did use manipulatives, they gained a better understanding of the abstract idea. This shows that manipulatives are effective when teaching fractions.

However, Group 1 Pretest and Posttest #1 did not have the expected outcomes that were anticipated. Since they learned about fractions using manipulatives the first week, the results were hypothesized that they would do better on their test than the other group that did not use manipulatives. Unfortunately, their results on the Pretest and Posttest #1 show that there is no correlation between the two Groups use of manipulatives.

The results of Group 1 could also be due to the fact that the majority of the students in Special Education ended up in the group even though they were randomly picked from a bag. These students tend to need more time and one-on-one support to fully grasp the concept and since we only spent a week on fractions before taking Posttest #1 they might not have fully understood fractions as much as a student who is not in special education. Also during week two of instruction, one student who was in Group 1 missed a few days of school due to a family member passing away so this child, who is in special education, got a 0 on Posttest #2 because the student did not have a lot of instruction and/or reinforcement of the material that was being taught.

Also, it can be noted that Group 2's pretests had a significantly higher average than Group 1. These students might have already had a basic understanding of fractions and might have remembered fractions from the previous school year.

Interestingly, one thing that was noticed was the groups that had just used manipulatives finished their test significantly faster than the group that did not just use manipulatives. This was noticed during both weeks. However, since it was not part of the methodology, no quantitative data was taken on it. Further research should be done to see if using manipulatives is a great way to teach students faster which can help teachers because there is 'never enough time in the day to do everything.'

It was also noticed, although not quantified, that students who used the manipulatives were able to grasp the concept faster than the other group that was not using manipulatives. This aligns with other research done on manipulatives where teachers have found that students do not understand abstract concepts unless given a manipulative to help them grasp the concept.

Also, there was supposed to be a week three for my research. The students were going to be given the opportunity to decide whether or not to use manipulatives. However, the concepts that were being taught during the third week were very abstract so the students who decided not to use manipulatives became very confused until they started using manipulatives. Because of this, all of the students were required to use manipulatives. It should also be noted that the tests were cut down to four questions because of lack of time and because they included material that was not taught.

If this research were to be done again, the researchers should try to obtain a larger pool of students. There were only 17 students who participated in the study. Also, the research should span for more than three weeks and should also cover different learning standards instead of just one. This could lead to more insight on how effective manipulatives are when students use them to understand abstract concepts.

Conclusion

In conclusion, the hypothesis was neither supported nor rejected. Since Group 2's results did reject the null hypothesis this shows us that manipulatives are effective. However, none of the other results rejected the null hypothesis so it cannot be said that the hypothesis was supported. More research should be done on this topic; especially research that involves more students and more learning standards. This way it can really be noted if manipulatives do have an effect on how well students understand abstract concepts.

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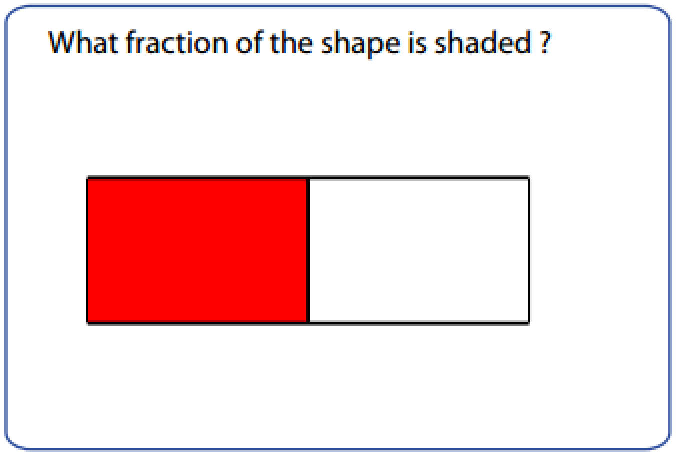
Appendix A

Name:____



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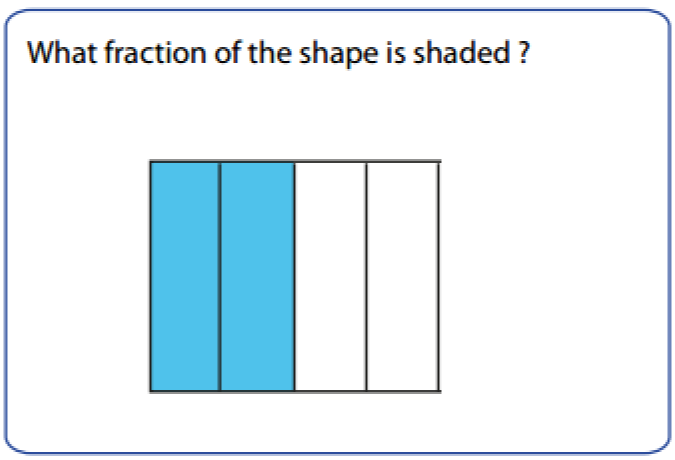

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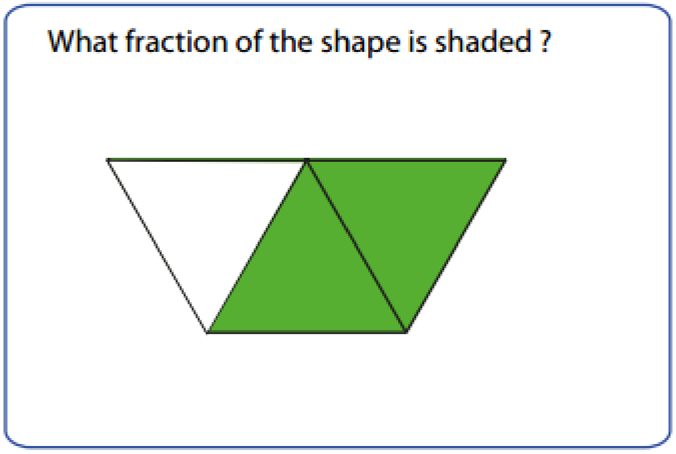
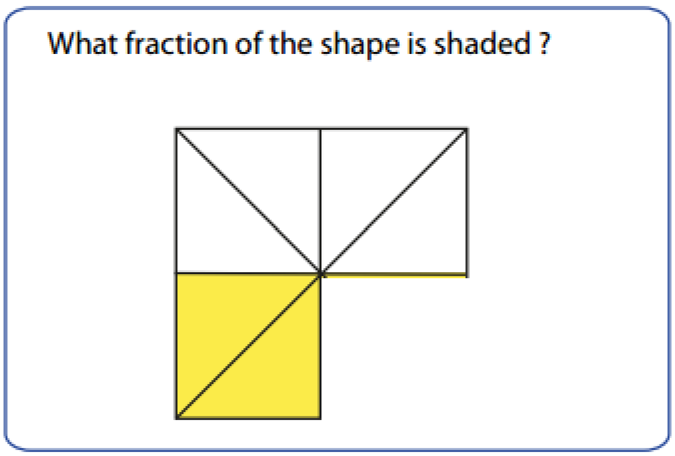
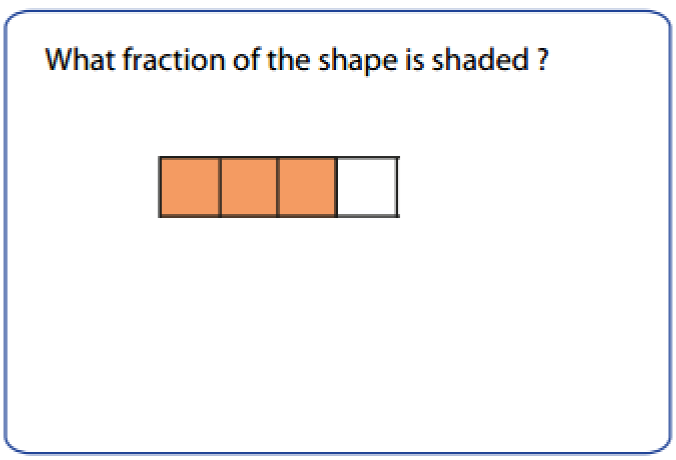

What fraction of the shape is shaded ?

3.


What fraction of the shape is shaded ?

4.


What fraction of the shape is shaded ?

5.

6. $\frac{1}{6} \bigcirc \frac{4}{8}$

7. $\frac{1}{2} \bigcirc \frac{2}{3}$

8. $\frac{2}{3} \bigcirc \frac{1}{4}$

9. $\frac{7}{8} \bigcirc \frac{1}{2}$

10. $\frac{3}{8} \bigcirc \frac{7}{8}$

11. Draw two thirds.

12. Draw six eighths.

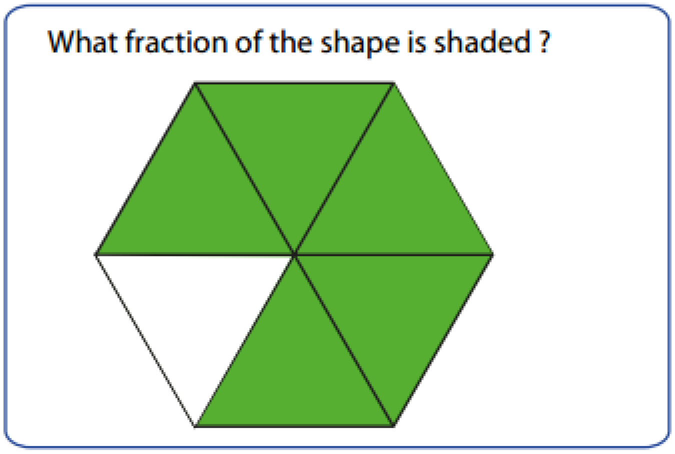
13. Draw three fourths.

14. Draw five sixths.

15. Draw one fourth.

Appendix B

Name:____



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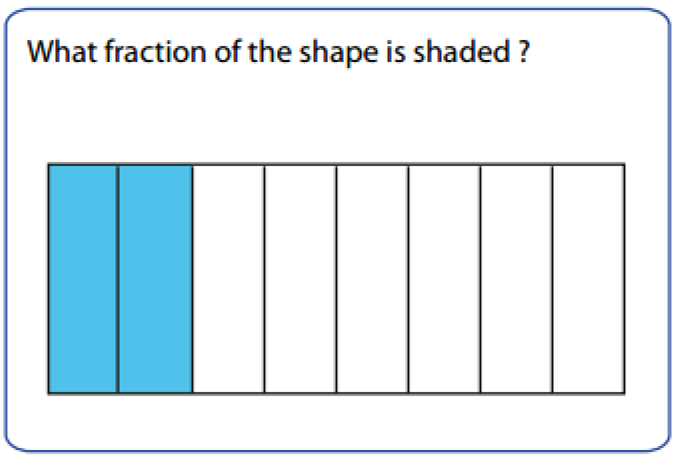

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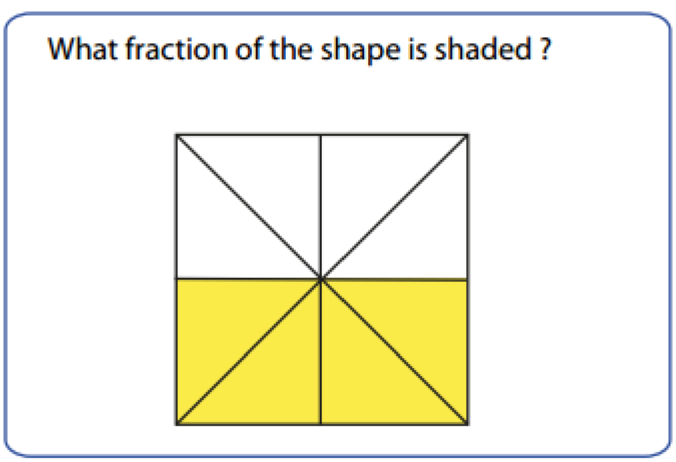

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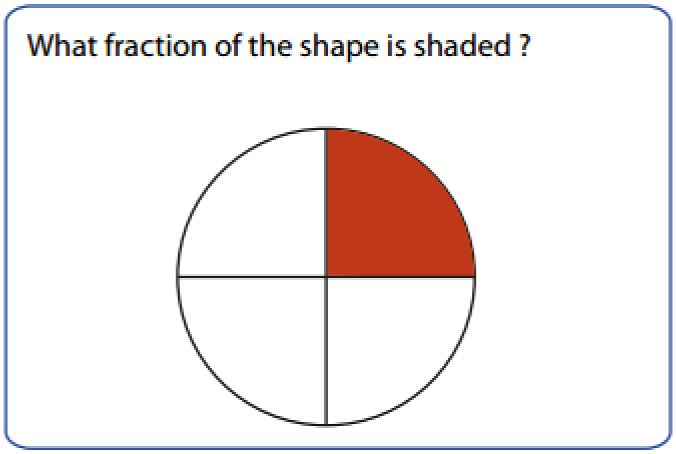

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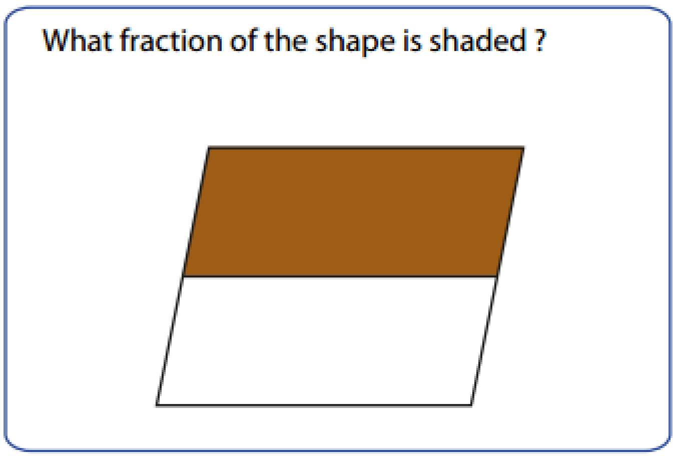


5.

$\frac{2}{3}$ ○ $\frac{4}{6}$

6.

$\frac{3}{8}$ ○ $\frac{7}{8}$

7.

$\frac{1}{4}$ ○ $\frac{1}{6}$

8.

$\frac{1}{2}$ ○ $\frac{4}{8}$

9.

$\frac{3}{8}$ ○ $\frac{7}{8}$

10.

11. Draw one half.

12. Draw three sixths.

13.Draw two thirds.

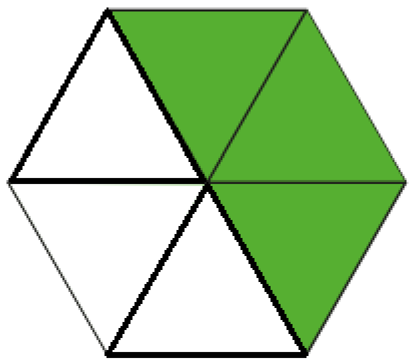
14. Draw four tenths.

15.Draw two eighths.

Appendix C

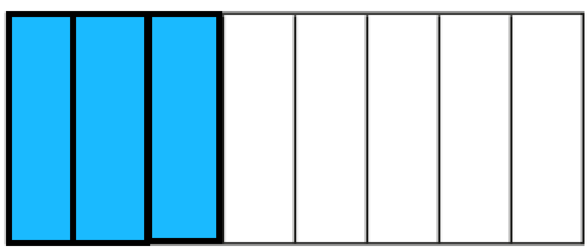
Name:____

What fraction of the shape is shaded ?



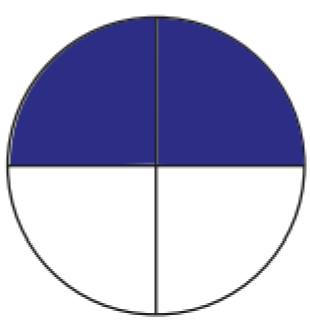
1.

What fraction of the shape is shaded ?



2.

What fraction of the shape is shaded ?

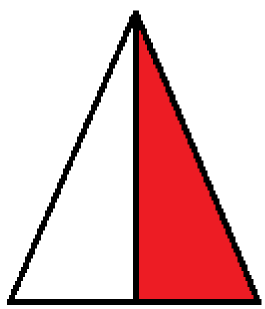


3.

What fraction of the shape is shaded ?

4.

What fraction of the shape is shaded ?



5.

$\frac{2}{3}$ ○ $\frac{1}{2}$

6.

$\frac{1}{2}$ ○ $\frac{1}{4}$

7.

$\frac{2}{3}$ ○ $\frac{1}{6}$

8.

$\frac{7}{8}$ ○ $\frac{4}{8}$

9.

10. $\frac{3}{8} \bigcirc \frac{1}{2}$

11. Draw one half.

12. Draw one third.

13. Draw six eighths.

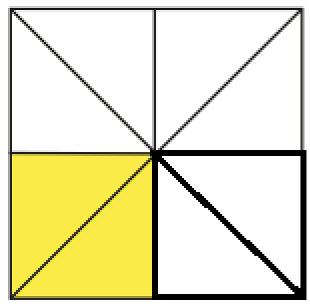
14. Draw four tenths.

15. Draw three sixths.

Appendix D

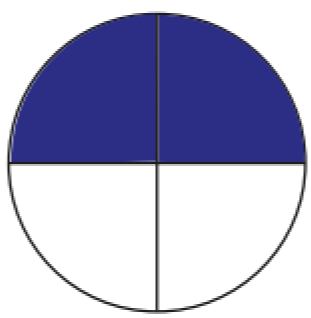
Name:____

What fraction of the shape is shaded ?



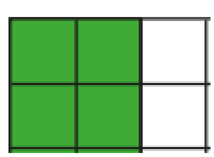
1.

What fraction of the shape is shaded ?



2.

What fraction of the shape is shaded ?



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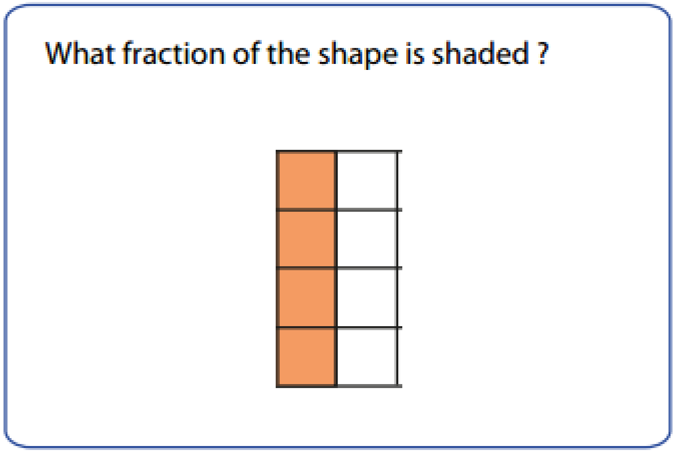
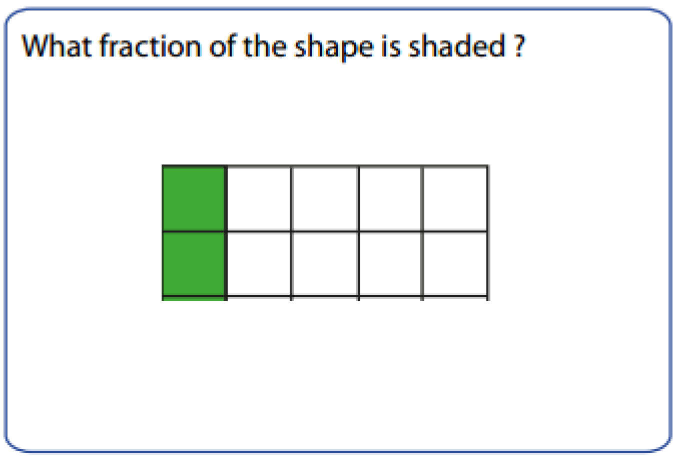


4.



5.

$$\frac{2}{4} \quad \square \quad \frac{3}{4}$$

6.

$$\frac{2}{4} \quad \square \quad \frac{2}{3}$$

7.

$$\frac{2}{4} \quad \square \quad \frac{4}{8}$$

8.

9. $\frac{1}{2}$ $\square$ $\frac{2}{4}$

10. $\frac{1}{2}$ $\square$ $\frac{1}{3}$

11. Draw four sixths.

12. Draw two fourths.

13. Draw five tenths.

14. Draw three fourths.

15. Draw one half.

Appendix E

Frequency Chart:

A check will be placed in the appropriate day if they used manipulatives. If they did not use manipulatives, I will place an ‘X’. If they are absent, I will write absent.

Name	Day 1	Day 2	Day 3	Day 4	Day 5
Student 1					
Student 2					
Student 3					
Student 4					
Student 5					
Student 6					
Student 7					
Student 8					
Student 9					
Student 10					
Student 11					
Student 12					
Student 13					
Student 14					
Student 15					
Student 16					
Student 17					
Student 18					
Student 19					

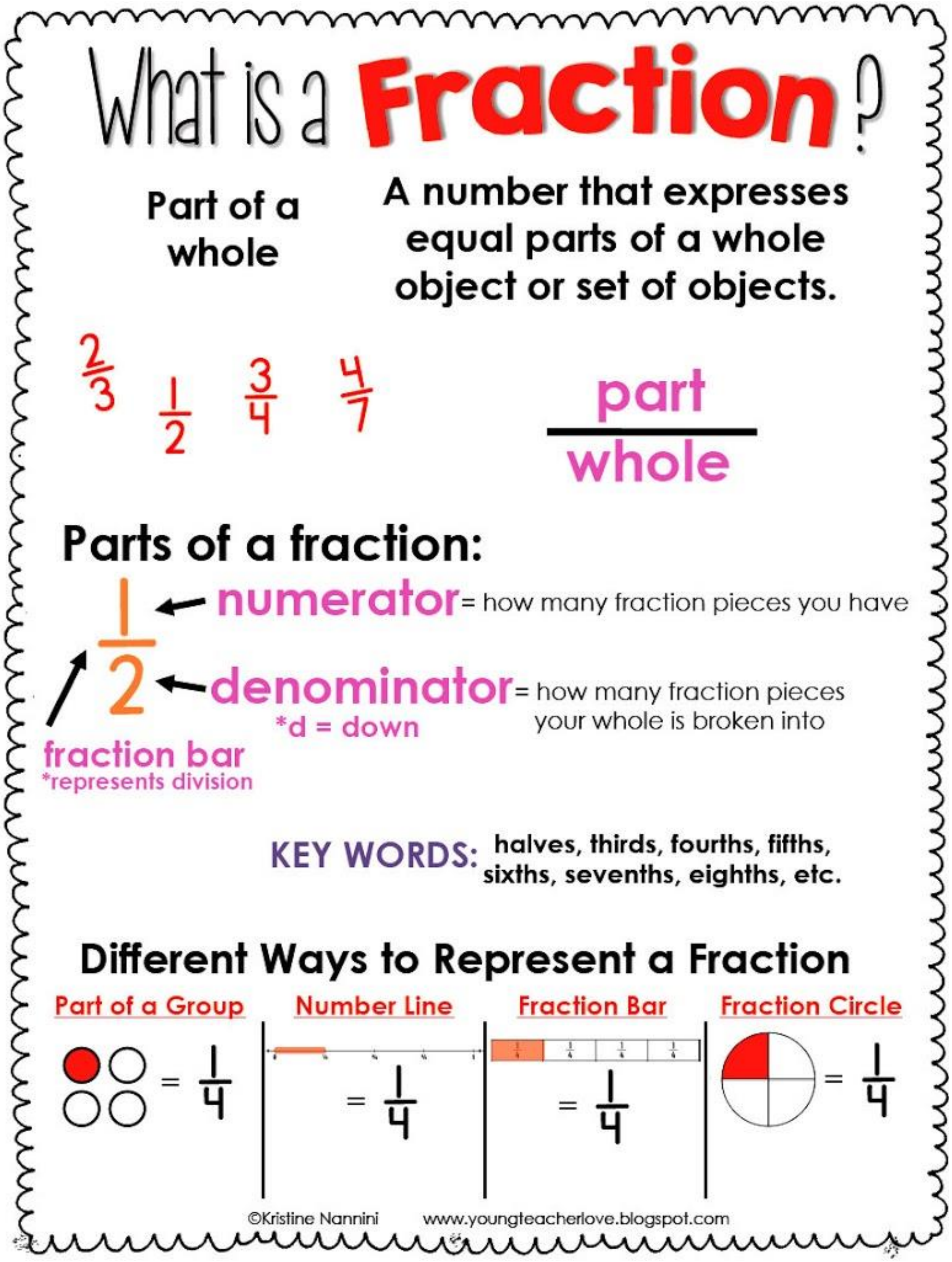
Student 20					
Student 21					

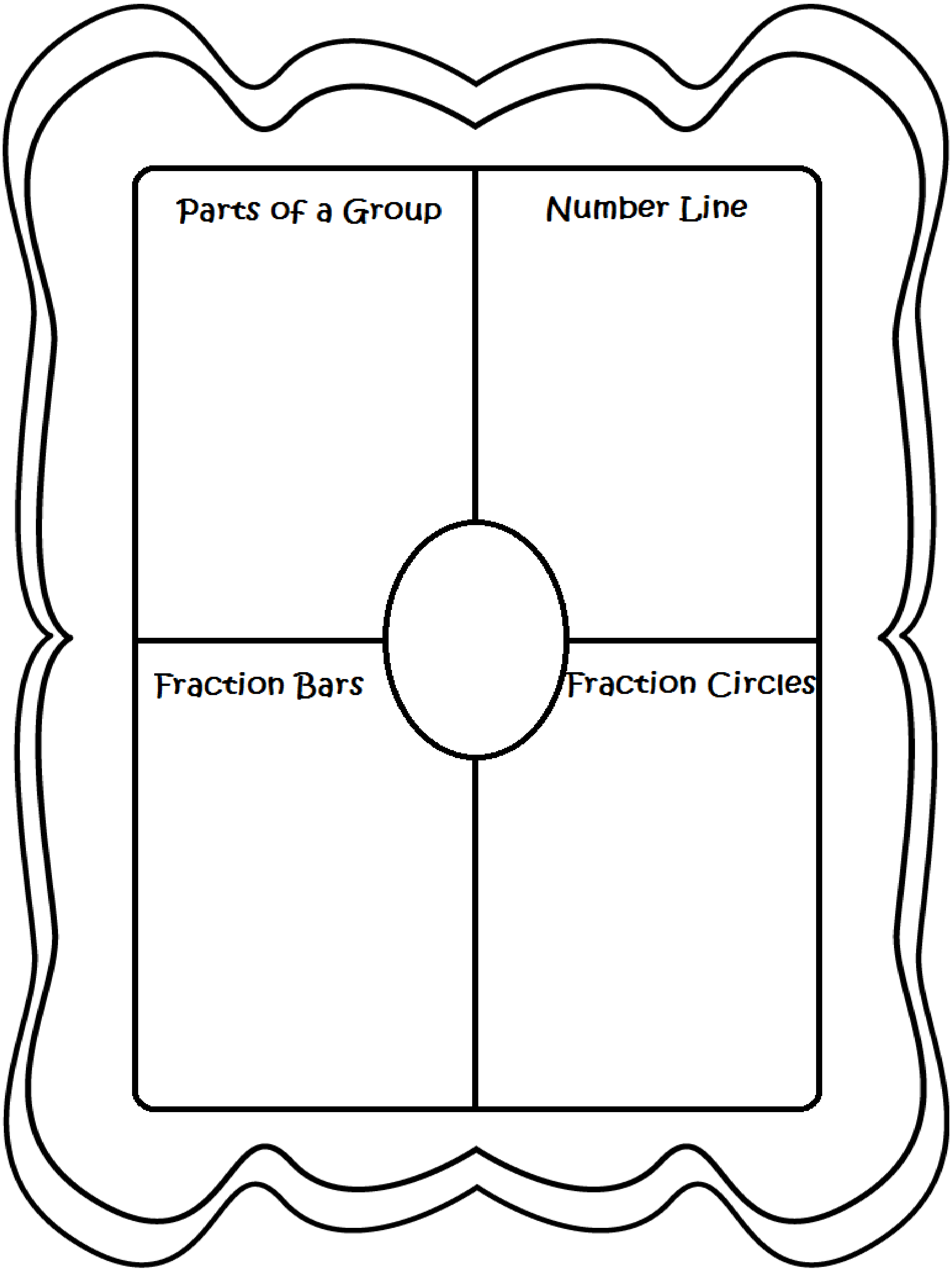
Appendix F

Lesson Title: Math Week 6 Day 1

Lesson Components	**Description**
Virginia Standards of Learning (VSOL)	2.3 The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
Objective ("KUD")	· The students will know: - That fractions are equal shares of a whole · Students will understand: - That fractions are equal shares of a whole - That the fraction name tells the equal part of a whole - That the larger the denominator, the smaller the part. · Students will be able to: - Identify fractions - Compare fractions - Write and draw fractions
Assessment/Monitoring	· An informal observation of their work during group work.
Procedures	Group 1: 1. Have the students bring their math journals. 2. Go over fractions by creating an anchor chart with the students. 3. Have students take notes along with you, creating their own fractions anchor chart. 4. Do the pizza story while modeling it with playdough. 5. pass out the playdough and have the students make ½ 1/3. ¼, 1/5, 1/6, 1/10 with their playdough. 6. Have them turn to a partner and make up their own fraction story with each other. Group 2: 1. Have the students bring their math journals. 2. Go over fractions by creating an anchor chart

	with the students. 3. Have students take notes along with you to create their own fraction anchor chart. 4. Pass out the What Fractions Look like worksheet. 5. Have students fill it out to represent the different fractions.
Materials/Equipment/ Preparation	● Fractions anchor chart ● Playdough ● What fractions look like worksheet ● Math Journals


What is a Fraction?
Part of a whole
A number that expresses equal parts of a whole object or set of objects.
2/3 1/2 3/4 4/7
part / whole
Parts of a fraction:
numerator= how many fraction pieces you have
denominator= how many fraction pieces your whole is broken into
*d = down
fraction bar
*represents division
KEY WORDS: halves, thirds, fourths, fifths, sixths, sevenths, eighths, etc.
Different Ways to Represent a Fraction
Part of a Group
Number Line
Fraction Bar
Fraction Circle
= 1/4
©Kristine Nannini
www.youngteacherlove.blogspot.com


Parts of a Group
Number Line
Fraction Bars
Fraction Circles

Lesson Title: Math Week 6 Day 2

Lesson Components	**Description**
Virginia Standards of Learning (VSOL)	2.3 The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
Objective ("KUD")	· The students will know: - That fractions are equal shares of a whole · Students will understand: - That fractions are equal shares of a whole - That the fraction name tells the equal part of a whole - That the larger the denominator, the smaller the part. · Students will be able to: - Identify fractions - Compare fractions - Write and draw fractions
Assessment/Monitoring	· An informal observation of their work during group work.
Procedures	Group 1: 1. Briefly go over what fractions are to refresh their memories. 2. Pass out playdough. 3. Have the students make fractions as part of a group. Do this for the different fractions. 4. Next, have students do fractions as circles. Have them make one circle, cut it into fractions and then make another circle with a different color and lay it on top to make the fraction. 5. Have the students make fraction bars using the playdough. The same way we did with the circles. 6. Next, have the student practice making fractions as a set/group with the playdough. 7. Have the students partner up.

	8. Have one student give a fraction and the other student must make that fraction out of part of a set using playdough. Group 2: 1. Go over what fractions are briefly 2. Explain to students that we can make fractions out of sets. 3. Do students for an example. “how many people have blonde hair.” Write it on a white board so they can see. 4. Next, pass out bird-watching buddies worksheet. For the worksheet, require them to write the fraction down. 5. When they are done, have them partner up and make their own fractions as a set and test each other with it.
Materials/Equipment/ Preparation	● Playdough ● Whiteboards ● Whiteboard markers ● Bird-watching buddies worksheet

Lesson Title: Math Week 6 Day 3

Lesson Components	**Description**
Virginia Standards of Learning (VSOL)	2.3 The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
Objective (“KUD”)	· The students will know: - That fractions are equal shares of a whole · Students will understand: - That fractions are equal shares of a whole - That the fraction name tells the equal part of a whole - That the larger the denominator, the smaller the part.

	· Students will be able to: - Identify fractions - Compare fractions - Write and draw fractions
Assessment/Monitoring	· An informal observation of their work during group work.
Procedures	Group 1: 1. Briefly go over what fractions are to refresh their memories. 2. Pass out the sticks used for fractions. 3. Pass out graph paper 4. Lie the long stick on the graph paper and ask them how many squares it takes up. They will say ‘x’ tell them that these are the individual pieces and that they make up the whole. This is the denominator. 5. Next, put down ‘x’ amount of pieces on top of the denominator on the graph paper. Ask them how many spots they take up. They will say ‘x’ amount. Tell them that this is the numerator. 6. Draw it on a whiteboard so they can visualize. 7. Have them make their own fractions with the fraction sticks. 8. Next, have the students test a partner on the fractions. Group 2: 1. Briefly go over what fractions are 2. Pass out the rainbow fraction bars. 3. Have the students color in the bars accordingly. 4. Ask them some questions on the rainbow fraction bars. See if they notice anything 5. Next, pass out worksheets where students have to color in the combo strips. 6. Allow them to complete this with a partner.
Materials/Equipment/	● Fraction Sticks

Preparation	● Rainbow Fraction Bars worksheet ● Crayons ● Color in the combo strips ● Graph paper

Lesson Title: Math Week 6 Day 4

Lesson Components	**Description**
Virginia Standards of Learning (VSOL)	2.3 The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
Objective ("KUD")	· The students will know: - That fractions are equal shares of a whole · Students will understand: - That fractions are equal shares of a whole - That the fraction name tells the equal part of a whole - That the larger the denominator, the smaller the part. · Students will be able to: - Identify fractions - Compare fractions - Write and draw fractions
Assessment/Monitoring	· Their posttest answers.
Procedures	Group 1: 1. Pass out the post-test. 2. Allow the students to complete the post-test. 3. If there is time start comparing fractions with the group using fraction sticks. Group 2: 1. Pass out the post- test. 2. Allow the students to complete the posttest. 3. If there is time, start comparing fractions using the rainbow fraction bars.

Materials/Equipment/ Preparation	• Fractions Post-test

Appendix G

Consent Letter

Dear Parent or Guardian,

Hello, my name is Maggie Neubig, and I am a student teacher in your child's classroom. I am currently a graduate student at the University of Mary Washington working towards my Masters in Elementary Education. A requirement of our program is to conduct an action research study in an area related to our studies. *I am inviting your child to participate in a research study I am doing. Involvement in the study is voluntary, so you may choose to have your child participate or not. I am now going to explain the study to you.*

I am interested in learning about the effectiveness of manipulatives while teaching fractions in 2nd grade. I will be running my research during the first three weeks of March. The students will be given a pretest and then split into two groups. One group will receive instruction on fractions using manipulatives and the other group will receive instruction on fractions with no manipulatives. During the following week, the student's instruction will switch. All students will eventually receive the same instruction.
I am requesting permission to use the data I collect on your child. ***This project will be part of your child's work for class. It will in no way require extra work for him or her.***

Your child's work will be kept confidential. His or her name will not appear in any papers in the project. All names will be changed to protect his or her privacy. Following the project, all samples I collect will be destroyed. Participation in this project will not affect your child's grade in any way. His or her participation in the study is voluntary, and you have the right to keep your child out of the study. Also, your child is free to stop participating in the study at any time. Your child would still participate in the classroom project, but data for the research study would not be collected from him or her.

This research should help the students understand fractions. It will also show teachers why it is important to correctly use manipulatives as tool to help students understand abstract concepts. The only potential risk is that your child may be hurt that they were placed in one group than the other and they might be upset that they are learning something different from the other group. This risk will be minimized by explaining to your child that the groups were randomly selected and that they will all eventually receive the same instruction.

If you have any questions or concerns, please do not hesitate to contact my University Supervisor Dr. Roberta Gentry (rgentry@umw.edu) or myself (mneubig@mail.umw.edu). Please return this form by **___________**?. I look forward to working with you and your student!

Thank you,

Maggie Neubig

I have read the above letter and give my child, ______________________________, permission to participate in this project.

____
(Parent/Guardian Signature)

I, ____________________________ agree to keep all information and data collected during this research project confidential.

____
(Researcher Signature)

Appendix H

Student Assent Letter

Dear Student,

I am very excited to be your student teacher throughout the spring! For part of our fractions unit, we will be working with and without manipulatives.

While you work in your groups, I will be collecting information for a research project that I am doing to see how manipulatives help you understand fractions. During my study, I will collect your test scores and use them to help me understand my research question..

Your parents were given a letter about taking part in this study. If your parents did not allow you to participate in this study, you will not be asked to sign this form. However, if your parents did allow you to participate, I encourage you to participate in this study.

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Nothing bad will happen if you take part in the study and nothing bad will happen if you do not. However, if you decide not to participate you still will work in groups and do all of the work that we will do; I will just not use your work in my research. Even if you start, you can stop later if you want. You may ask questions about the study.

If you decide to be in the study, I will keep your information confidential. This means that I will not use your names or the name of the school in anything I write and I will not reveal any personal, identifying information about you.

Signing this form means that you have read it or have had it read to you, and that you are willing to be in this study. If at any point you have any questions, please ask me!

Thanks,

Ms. Neubig

I have been read the above letter, all my questions have been answered, and I agree to participate in the project.

______________________________ ___________________________

(Student Signature) (Date)

(Student Signature) (Date)

I, ____________________________ will keep your names confidential.

______________________________ ______________________________

(Student Teacher/Researcher Signature) (Date)